THE WESTERN
Journal of Medicine

Refer to: Calcaterra TC, Moseley JI, Rand RW: Cerebrospinal rhinorrhea—Extracranial surgical repair. West J Med 127: 279-283, Oct 1977

Cerebrospinal Rhinorrhea

Extracranial Surgical Repair

THOMAS C. CALCATERRA, MD; JOHN I. MOSELEY, MD, *and* ROBERT W. RAND, MD
Los Angeles

Cerebrospinal rhinorrhea is an uncommon complication of head trauma or of diverse types of intracranial diseases. Because of the risk of meningitis, this condition warrants immediate attention. If the leak fails to stop spontaneously in a short time, the precise site of the leak must be ascertained and surgical repair attempted. For the past 50 years craniotomy has been the principal operative approach; however, this method carries the risk of significant morbidity and protracted hospital stays, as well as a disappointing incidence of persistent leak. During the past decade extracranial operations for dural repair have been devised, and experience in the management of patients by a variety of such procedures illustrates the success of these operations.

A SPINAL FLUID LEAK from the intracranial space to the nasal respiratory tract is potentially very serious because of the risk of an ascending infection which could produce fulminant meningitis. The earliest attempts to seal these leaks were carried out extracranially by applying various cauterizing agents to the roof of the nose. Certainly most of these efforts were unsuccessful, although some authors reported cessation of rhinorrhea which may have been fortuitous or perhaps secondary to mucosal scarring.[1] After Dandy[2] documented the first successful intracranial repair of a cerebrospinal fluid (CSF) leak in 1926, management of this condition was almost exclusively by craniotomy. However, with the advent of the operating microscope and more refined methods of localizing the dural defect, extracranial methods of dural repair became increasingly attractive because of their inherent reduced morbidity. Our experience at the University of California, Los Angeles, Hospital with 14 patients in whom various extracranial operations were carried out during the past five years is presented.

From the Department of Surgery, Divisions of Head and Neck Surgery and Neurosurgery, University of California, Los Angeles, School of Medicine.

Submitted, revised, February 10, 1977.

Reprint requests to: Thomas C. Calcaterra, MD, Department of Surgery, University of California, Los Angeles, Center for the Health Sciences, Los Angeles, CA 90024.

Causes

Skull trauma with dural tearing is unequivocally the most common cause of cerebrospinal rhinorrhea. Usually the fracture involves some portion of the anterior cranial fossa floor with the leaks occurring through the cribriform plate or ethmoid sinus roof into the nose. Another frequently seen anterior fossa fracture site is the posterior wall of the frontal sinus through which CSF can escape into the nose via the nasofrontal duct. Less common are middle cranial fossa fractures that can cause leakage to the nose via the sphenoid sinus or eustachian tube. Such leakage may also occur when there is a fracture of the petrous bone allowing fluid to enter the mastoid

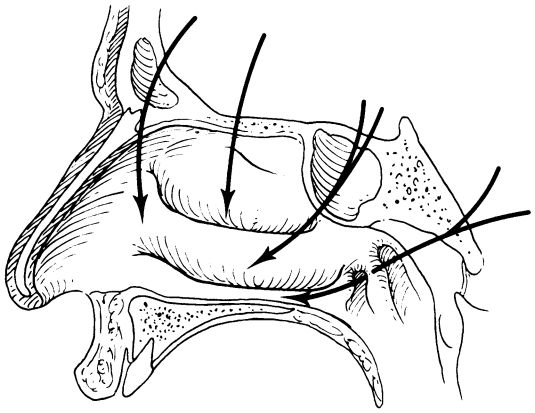

Figure 1.—Pathways of cerebrospinal fluid (CSF) leakage. Arrows show varied routes of CSF leaks to the nasal cavity.

air system. If the tympanic membrane is torn, the fluid will exit through the external ear canal; however, if the membrane is intact, spinal fluid will escape through the eustachian tube (Figure 1). For reasons that are not well understood, cerebrospinal rhinorrhea may occur as late as several months after skull fracture; this phenomenon was observed in three of our patients.

Included in the trauma category is iatrogenic cerebrospinal rhinorrhea, as seen in five of our patients (Table 1). This complication may follow extracranial surgical procedures such as sinus and mastoid operations. Likewise, intracranial operations may also involve dural tearing that permits leakage into the upper respiratory tract.

Nontraumatic cerebrospinal fluid fistulae tend to occur less frequently, and most of them are related to diseases that cause increased intracranial pressure or local skull destruction. Such conditions include hydrocephalus, primary or metastatic intracranial tumors, osteomyelitis of the skull and brain cysts. Congenital defects of the skull can also serve as the source of fistulae, usually occurring in the anterior cranial fossa. These are believed to represent mesodermal development disorders, inasmuch as dura and bone develop from this layer while pia and arachnoid develop from ectoderm.[3]

Diagnosis

Confirming the presence of cerebrospinal rhinorrhea is usually not difficult, particularly when there are antecedent factors such as head trauma or surgical operation, or when there is a clear watery discharge draining from one nostril. Often the spinal fluid can be initiated or increased by a Valsalva maneuver or by compression of both jugular veins. However, glucose determination made by glucose oxidase test papers is unreliable because of the reducing substances present in lacrimal gland secretions and nasal mucus. Quantitative glucose and protein determination of the suspected nasal fluid should therefore be done to confirm the diagnosis.

The precise localization of the dural defect is far more challenging. Factors in the patient's history may be helpful in identifying the site of the leak. A gush of fluid that occurs when the head changes position suggests a collection of fluid in one of the sinuses, particularly the sphenoid. A deficient sense of smell indicates an injury near the olfactory area, while a sense of fullness in the ear or a hearing loss implicates CSF in the middle ear.

Tomography of the paranasal sinuses or the base of the skull, or both, may show there to be an osseous defect or pneumocephalus. A sinus

TABLE 1.—*Extracranial Management of Cerebrospinal Fluid Leaks*

Patient and Site	*Cause*	*Operation*
1. postfrontal wall	blunt trauma	frontal osteoplastic flap and external ethoidectomy
2. postfrontal wall	blunt trauma	frontal osteoplastic flap
3. lateral recess frontal sinus	craniotomy	frontal osteoplastic flap
4. ethmoid roof	blunt trauma	external ethmoidectomy
5. ethmoid roof	blunt trauma	external ethmoidectomy
6. ethmoid roof	intranasal ethmoid surgical operation	external ethmoidectomy
7. cribriform plate	spontaneous	external ethmoidectomy plus tissue glue
8. cribriform plate	blunt trauma	external ethmoidectomy plus tissue glue
9. sphenoid sinus	blunt trauma	transseptal sphenoidotomy
10. spehnoid sinus	idiopathic	external ethmoidectomy and sphenoidotomy
11. petrous apex	craniotomy	tympanic cavity obliteration
12. petrous apex	craniotomy	tympanic cavity obliteration
13. petrous tegman	mastoid operation	mastoidectomy and temporalis muscle flap
14. petrous tegman	gunshot	mastoidectomy and temporalis muscle flap

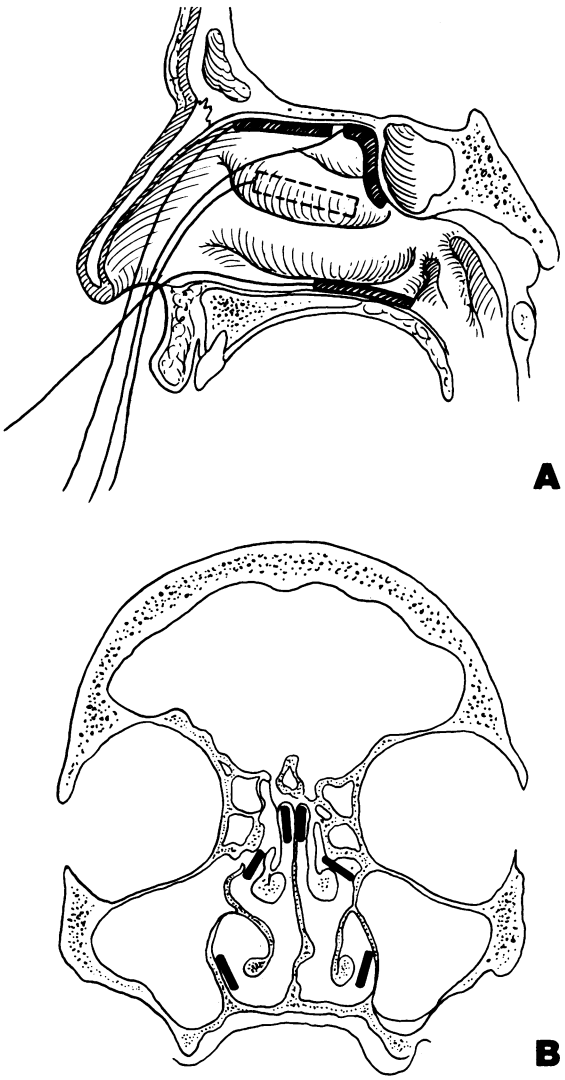

Figure 2.—Placement of cottonoid pledgets. **A,** Sagittal view of the nasal cavity showing anatomic location of pledgets. **B,** Coronal view of nasal cavity showing the same pledgets.

adjacent to a CSF leak can show increased density or an air-fluid level. The sugar content of the spinal fluid may cause local sinus mucosal edema which can be documented by radiographs.[4]

Injection of various types of marking substances into the intrathecal space has been utilized to localize the dural defect. Although radioisotopes are helpful in determining whether a leak is present, they often cannot show the fine detail required to localize the site of the leak. In our experience, vital dyes such as fluoresceine or indigo carmine used in conjunction with cottonoid pledgets which are placed strategically in the nose have provided the best information. In this procedure, the nasal cavities are sprayed with a 4-percent solution of cocaine to anesthetize and shrink the mucous membranes. Cottonoid pledgets are then placed into the (1) anterior roof of the nose, (2) posterior roof and sphenoethmoid recess and (3) middle meatus (Figure 2).

A lumbar puncture is then done and the opening pressure recorded (it may be quite low if the leak is copious). At least 10 ml of spinal fluid is withdrawn, mixed with dye, and then slowly reinjected into the intrathecal space. After the patient has been recumbent for about 30 minutes, his nose is examined and the cottonoid pledgets are removed. The area of cottonoid staining identifies the site of the leak. Staining of the pledget in the middle meatus indicates a leak of the frontal sinus. If the anterior nasal roof cottonoid is stained, a leak exists at the cribriform plate or anterior ethmoid roof. When the pledgets placed in the posterior nasal roof and sphenoethmoid recess are discolored, the posterior ethmoid region or sphenoid sinus is involved. Staining of the posterior pharyngeal wall suggests that fluid is emanating via the eustachian tube. Dye may also be seen behind the tympanic membrane.

Patients and Methods

Since 1970 the authors have carried out extracranial operations at UCLA Hospital on 14 patients to repair persistent CSF leakage. Other patients with this condition were seen during this period; however, in those cases the leak was stopped either by conservative management or by craniotomy (generally done in the earlier years of the series). The location of the leak and the methods of surgical repair are summarized in Table 1.

Treatment

Acute leaks resulting from head trauma or various types of cranial surgical procedures were managed conservatively whenever possible. This treatment generally consisted of a two-week trial of bedrest in a semisitting position, lumbar taps twice a day or continuous spinal fluid drainage, and administration of prophylactic antibiotics. These patients were cautioned against noseblowing, sneezing and straining. On the other hand, immediate repair of the dura was done in those patients who had suffered severe cranial injury necessitating operative intervention for other reasons, if the leak was associated with intracranial air or complicated by meningitis. In the latter instance, the operative procedure was car-

ried out as soon as the meningitis had been completely cleared by antibiotic therapy.

A trial of conservative management was not necessarily considered for patients in whom the leak followed a head injury by several days or there was no history of head trauma, inasmuch as these conditions rarely heal spontaneously. Those patients with nontraumatic leaks in whom the source of the leak was not apparent were admitted to the neurosurgical service for complete evaluation to determine if an occult intracranial lesion was present.

As we gained experience with the management of CFS leakage, we employed extracranial methods of repair more often because of their reduced morbidity. As in the case of an intracranial repair, it is extremely important to precisely locate the dural defect before the operation, to assure selection of an appropriate extracranial approach which would afford maximum exposure of the dural dehiscence. Likewise, in order to pinpoint the dural defect intraoperatively, intrathecal dye was injected during the operation; this was done just after induction of general anesthesia. An indwelling catheter was placed in the lumbar subarachnoid space, and about 30 minutes before the anticipated exposure of the dural leakage site, spinal-fluid-diluted dye was slowly injected. By the time the leak was exposed, a discrete flow of dye-stained spinal fluid was seen trickling from the dural defect. The anesthesiologist can augment this flow by applying prolonged positive pressure ventilation to the patient. Without staining the spinal fluid, small leaks may not be visible, particularly if absolute hemostasis cannot be achieved in the operative field. The indwelling spinal catheter serves a second purpose by permitting continuous drainage for three to five days after operation, thereby maintaining a low spinal fluid pressure and insuring better healing of the dural repair.

Operative Experience

The extracranial surgical procedures in this series were done to repair leakage from four anatomic sites: (1) frontal sinus, (2) cribriform plate and ethmoid roof, (3) sphenoid sinus and (4) petrous bone.

Frontal Sinus

In three patients there was leakage through the frontal sinus. In all of them it was secondary to traumatic tears of the dura over the frontal lobe. An extracranial approach to this area was accomplished with an osteoplastic frontal bone flap through a coronal scalp or eyebrow incision.[5] This operation enabled visualization of the posterior wall of the frontal sinus where the bony defect was found. The area of the dural tear was exposed by removing adjacent bone with a drill burr or forceps; closure of dura was accomplished by direct suture approximation or by mattress suture of a connective tissue graft such as a frontalis fascia. To further ensure the seal, the frontal sinus may be packed with fat after all mucous membrane has been removed.

Cribriform Plate and Ethmoid Roof

Five patients were found to have leaks from this region and in all exploration was carried out through a curved naso-orbital incision. Access to the ethmoid roof or the cribriform plate required a complete ethmoidectomy. Leaks at either site were sealed with mucoperiosteal flaps rotated either from the lateral nasal wall or the nasal septum. The operating microscope greatly facilitated visualization of the leak as well as manipulation of the flaps (which on two occasions were secured with tissue adhesives). Further stabilization of the flaps was obtained with absorbable packing such as oxidized cellulose (Surgicel®).

Sphenoid Sinus

Two patients in the series had CSF leaks through the sphenoid sinus. In one patient the defect was approached between the septal membranes[6] and in the other through the ethmoid sinuses.[7] The transseptal approach has the advantage of avoiding a facial incision and allows sphenoid sinus packing without an open communication with the nasal cavity. However, if the leak cannot be precisely localized to the sphenoid sinus by preoperative studies, then it is better to approach this region through the ethmoid sinuses. In either case, the intersinus septum is removed and the sphenoid sinus denuded of its mucosa under visualization with the operating microscope. The sinus is then packed with thigh muscle fragments buttressed by septal bone.

Petrous Bone

Almost all of the dura surrounding the petrous bone can be approached extracranially from below. In four patients in this series there were leaks from dural defects adjacent to the petrous bone, two of which were repaired by direct dural

exposure by mastoidectomy. In two others packing of the eustachian tube through the middle ear was done to seal the leak.[8] With mastoidectomy, the dural defect is covered with fascia buttressed by a temporalis muscle pedicle. Sealing the eustachian tube and middle ear through the auditory canal will effectively prevent CSF from entering the pharynx; however, this technique should be used only in patients who have a permanent total hearing loss.

Results

An extracranial operation successfully achieved permanent sealing of the spinal fluid leak in all 14 patients. There were no significant postoperative complications. Although in patient 1 (Table 1) a successful repair of a leak through a frontal sinus fracture was achieved, another unexpected leak through the ethmoid roof had to be closed after the initial operation. The first attempt to seal the defect in patient 2 (Table 1) failed, but a second operation using the same approach was successful. Intracranial repair of the dural defect by craniotomy had been attempted previously in six of the patients. The follow-up periods ranged from four months to seven years, and there have been no instances of leak recurrence.

Summary

Successful management of cerebrospinal fluid rhinorrhea begins with a thorough diagnostic evaluation to determine the cause of the leak when it is not evident and to locate precisely the site of the leak if spontaneous cessation does not occur. Topographic mapping of the nasal fossa with strategically placed cottonoid pledgets to detect the leakage site of stained spinal fluid has proved invaluable in locating the dural defect. If the leak is not secondary to a brain tumor, our experience strongly suggests that the initial method of repair should be an extracranial operation selected to provide maximum exposure of the dural defect. This therapy will result in shorter hospital stays, less patient morbidity and a higher percentage of initial successful repairs.

REFERENCES

1. Fox N: Cure in case of cerebrospinal rhinorrhea. Arch Otolaryngol 17:85-86, 1933

2. Dandy WD: Pneumocephalus (intracranial pneumatocele or aerocele). Arch Surg 12:949-982, 1926

3. Grahne B: Spontaneous cerebrospinal rhinorrhea. Acta Otolaryngol 70:383-391, 1970

4. Grahne B: Traumatic cranionasal fistulas, persistent cerebrospinal fluid rhinorrhea and their repair with frontal sinus osteoplasty. Acta Otolaryngol 70:393-300, 1970

5. Calcaterra TC, Strahan R: Osteoplastic flap technique for disease of the frontal sinus. Surg Gynecol Obstet 132:505-509, 1971

6. Calcaterra TC, Rand RW: Current adjuncts in surgery of the sphenoid sinus. Laryngoscope 86:1692-1698, 1976

7. Jenkins HA, Calcaterra TC: Spontaneous cerebrospinal rhinorrhea from the sphenoid sinus. Trans Am Acad Ophthalmol Otolaryngol (in press)

8. Calcaterra TC, Rand RW: Tympanic cavity obliteration for cerebrospinal otorhinorrhea. Arch Otolaryngol 97:388-390, 1973